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US Army Corps
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Construction Engineering
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TECHNICAL REPORT N-60
February 1986

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Acoustic Directivity Patterns for Army Weapons Supplement 4: The Multiple Launch Rocket System

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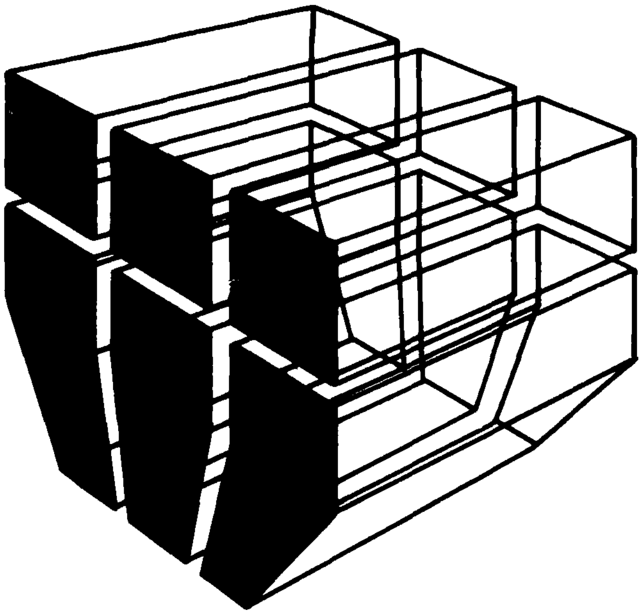
by
Paul D. Schomer



Environmental noise emissions of the Multiple Launch Rocket System (MLRS) weapon were measured in order to develop acoustic directivity patterns. Ignition noise was analyzed using C-weighting and separated from rocket engine noise, which was analyzed using A-weighting. The vehicle track noise, being very similar to that of the Bradley Fighting Vehicle (BFV), reported in Supplement 3, was not measured.

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Environmental noise emissions of the Multiple Launch Rocket System (MLRS) weapon were measured in order to develop acoustic directivity patterns. Ignition noise was analyzed using C-weighting and separated from rocket engine noise, which was analyzed using A-weighting. The vehicle track noise, being very similar to that of the Bradley Fighting Vehicle (BFV), reported in Supplement 3, was not measured.

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FOREWORD

This effort was funded by the U.S. Army Missile Command, Redstone Arsenal, AL under IAO MLRS-85-01, dated 26 November 1984, Change 1, dated 25 June 1985.

The work was done by the Environmental Division (EN), U.S. Army Construction Engineering Research Laboratory (USA-CERL). Dr. R. K. Jain is Chief of EN. Dr. L. R. Shaffer is Technical Director of USA-CERL, and COL Paul J. Theuer is Commander and Director.

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ACOUSTIC DIRECTIVITY PATTERNS FOR ARMY WEAPONS: SUPPLEMENT 4: THE MULTIPLE LAUNCH ROCKET SYSTEM

1 INTRODUCTION

Background

On 20 May 1981, the Army instituted the Installation Compatible Use Zone program (ICUZ). Under ICUZ, an Army installation works with the local civilian community to find ways to prevent or lessen the encroachment of off-installation housing and other noise-sensitive land uses into areas that are, or are likely to be, impacted by Army training noise.[1]

Vital to the success of the ICUZ program is a noise-prediction computer tool developed by the U.S. Army Construction Engineering Research Laboratory (USA-CERL). The Integrated Noise Contour System (INCS) creates noise zone maps using data on the type, frequency, and time of training operations; weapons types and charge sizes; and target and firing point locations. These zone maps portray the yearly average total noise emissions of an installation. When overlayed on a map of an installation and its environs, these zones identify existing or potential conflicts between noise levels produced by training operations and noise-sensitive land uses on or near an installation. Using BNOISE 3.2, the blast noise prediction computer program associated with INCS, zone maps also can be created that predict how changes in training range operations, siting, use intensity, and weapon types will alter an installation's noise-impact profile.[2] The Army Environmental Hygiene Agency (AEHA) can make noise predictions for any Army installation using USA-CERL's INCS/BNOISE 3.2 program.

Zone maps predict total yearly average noise emissions of an installation. Whether a noise problem exists, however, depends on numerous factors such as proximity of noise-sensitive land uses to range areas, weapon type, frequencies of operations, and time of day. For this reason, no "acceptable" or "excessive" levels have been defined for specific weapons. Nevertheless, one important data type needed for INCS/BNOISE 3.2 is the individual acoustic directivity pattern associated with each impulse-noise-producing weapon in the Army inventory. These patterns form a standard module of data for the INCS/BNOISE 3.2 prediction program.

USA-CERL Technical Report (TR) N-60 lists directivity pattern data obtained during tests at Fort Sill, OK, for many weapons used routinely in Army training.[3] Supplements, 1, 2, and 3 to TR N-60 contain directivity pattern data for the LAW and TOW anti-tank weapons, three regularly used weapon simulators; the proposed Abrams Tank (M1-E1) 120-mm main gun; and the Bradley Fighting Vehicle 25-mm M242 main gun, respectively.

Purpose

The purpose of this study was to determine the acoustic directivity pattern of Multiple Launch Rocket System (MLRS) emissions. (The vehicle track and engine noises were not measured for this test since this vehicle is acoustically very similar to the Bradley Fighting Vehicle.)

Approach

Noise measurements were made on the MLRS at White Sands Missile Range, (WSMR), NM. The measurement method was basically the same as that described in USA-CERL TR N-60. Weapon firings were interspersed with detonations of C-4 plastic explosive. The C-4 was used to "calibrate" the site and provide for correcting the data for wind and terrain effects.

Mode of Technology Transfer

The directivity patterns obtained from this study have been added to the INCS/BNOISE 3.2 input data bank and are available for use by AEHA and all Department of Defense activities.

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[1] Paul D. Schomer, "Noise Impact Prediction and Control," *Military Engineer*, Volume 74, Number 479 (April 1982).

[2] Paul D. Schomer, et al., *Blast Noise Prediction Volume I: Data Bases and Computational Procedures*, and Lincoln M. Little, et al., *Volume II: BNOISE 3.2 Computer Program Description and Program Listing*, Technical Report N-98/ADA 099440 and ADA099335 (U.S. Army Construction Engineering Research Laboratory [USA-CERL], 1981).

[3] P. D. Schomer, L. M. Little, and A. B. Hunt, *Acoustic Directivity Patterns for Army Weapons*, Technical Report N-60/ADA066223 (USA-CERL, 1979).

2 DATA COLLECTION AND REDUCTION

Data Collection

Measurements were performed at WSMR as part of the Fly To Buy test at that facility. The test site was the Tula range for the MLRS at WSMR. Figure 1 shows the general test area, Figure 2 shows the detailed test site layout, and Appendix A contains measurement site coordinates. There were two concentric rings of sensors; the inner ring had a radius of 250 m and the outer ring had a radius of 500 m. Both sensor rings were on flat open areas. (The inner ring provides the primary data; the outer ring is used for quality control as outlined in TR N-60, Supplement 2, Appendix C.) Sensors were located 90° to the right of the line-of-fire (LOF) rather than at 120° because of the protective berm (Figure 2). The measurements were made during January 1985.

For this test, there were two C-4 firing points: one by the MLRS vehicle and one about 100 ft* to the left of the vehicle (Figure 2). Because C-4 could not be set close to the vehicle and test van, the site to the left was used for the actual test. Events 1 through 10 were used to compare C-4 at the vehicle point versus C-4 at the alternate site. These data, contained in Appendix B, show no significant differences in the results when the C-4 site was changed.

The microphones on the inner ring were Endevco piezoresistive transducers close-coupled to USA-CERL-built preamplifiers and line drivers. (Appendix B of Supplement 1 describes the Endevco device and the USA-CERL preamplifiers.) Each microphone was wired to the USA-CERL mobile field acoustics laboratory, where the signal was recorded on an Ampex PR2230 14-channel FM recorder.

The outer ring consisted of a variety of equipment. Sites 8 through 12 each had a B&K 4921 outdoor microphone, a USA-CERL "Blue-Box" noise monitor,[4] and a Nagra DJ tape recorder. Sites 8 and 12 were operated over a long cable by personnel at sites 9 and 11, respectively. USA-CERL line drivers were used to vary amplifier gain for these two remote stations. Site 7 had a B&K 4921 microphone system connected over a long line to the van and its PR2230 FM tape recorder. USA-CERL Blue-Box noise monitors were also used in the van for immediate data checking and readout.

Calibration

Calibration was performed (1) at the beginning and end of each tape and/or testing period, (2) when the equipment or equipment placement was changed, and (3) when any equipment malfunction was suspected. The six Endevco stations were calibrated with a B&K 4420 pistonphone. USA-CERL constructed special housings for the Endevco microphones so calibration could be performed using standard laboratory and field devices. At the beginning of each FM tape, the calibration tone was recorded for about 15 seconds at the measurement tape speed of 30 in./second (762 mm/second). The B&K 4921 microphone system was calibrated initially using the B&K-type 4220 pistonphone. Subsequent calibrations were performed using its internal 1000-Hz electrostatic actuator.

Test Sequence

The standard MLRS round was tested. Table 1 lists the test sequence for these rounds and the C-4 calibration shots. This is essentially the same procedure used during the original Fort Sill measurements and the measurements described in Supplements 1, 2, and 3.

Data Reduction

Initial data reduction was performed using the USA-CERL-developed True-Integrating Environmental Noise Monitor and Sound-Exposure Level Meter. This data reduction resulted in a measure of the C-weighted sound exposure level (CSEL). The Data 6000 computing oscilloscope was used to remeasure all inner ring sites in order to separate ignition (blast) noise from the more continuous motor noise. Background noise was also measured to ensure that the recorded data were far enough above the noise level to be valid. Table 2 lists analyzed ignition (blast) data by event.

The ignition data were first corrected by the adjacent (in-time) C-4 calibration events (11, 12, and 20 through 23). The C-4 data were corrected to data for an omnidirectional hemispherical (actually circular in the ground plane) radiating source. The MLRS data were averaged by microphone and corrected by the set of numbers found to convert the C-4 to a perfect, circular source. These averages are listed in Appendix C. These individual MLRS data (after correction by adjacent C-4 calibration) were then combined (energy-averaged by microphone) to form

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*1 ft = 0.3048 m.

[4] Aaron Averbuch, et al., *True-Integrating Environmental Noise Monitor and Sound-Exposure Level Meter, Volumes I through IV*, Technical Report N-41/ADA050958, ADA072002, ADA083320, and ADA083321 (USA-CERL, 1978, 1979, and 1980).

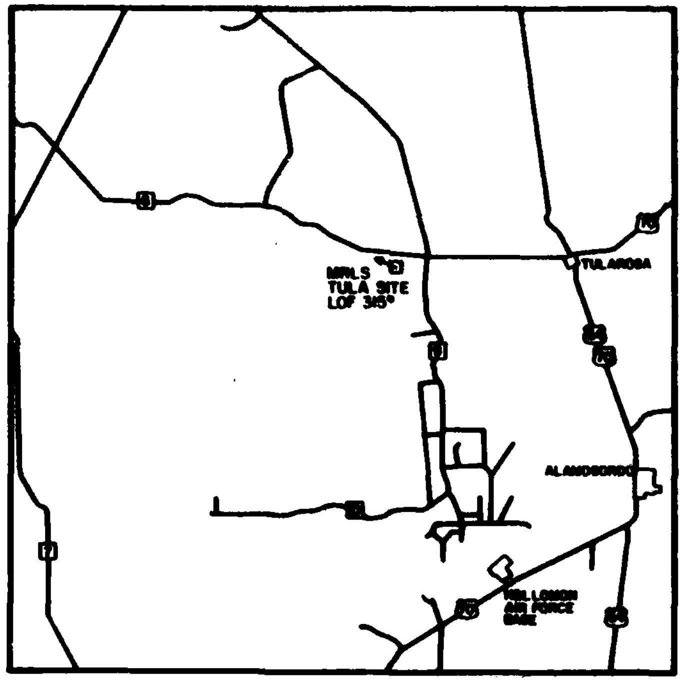


Figure 1. General site layout for noise measurements of the MLRS at WSMR, January 1985.

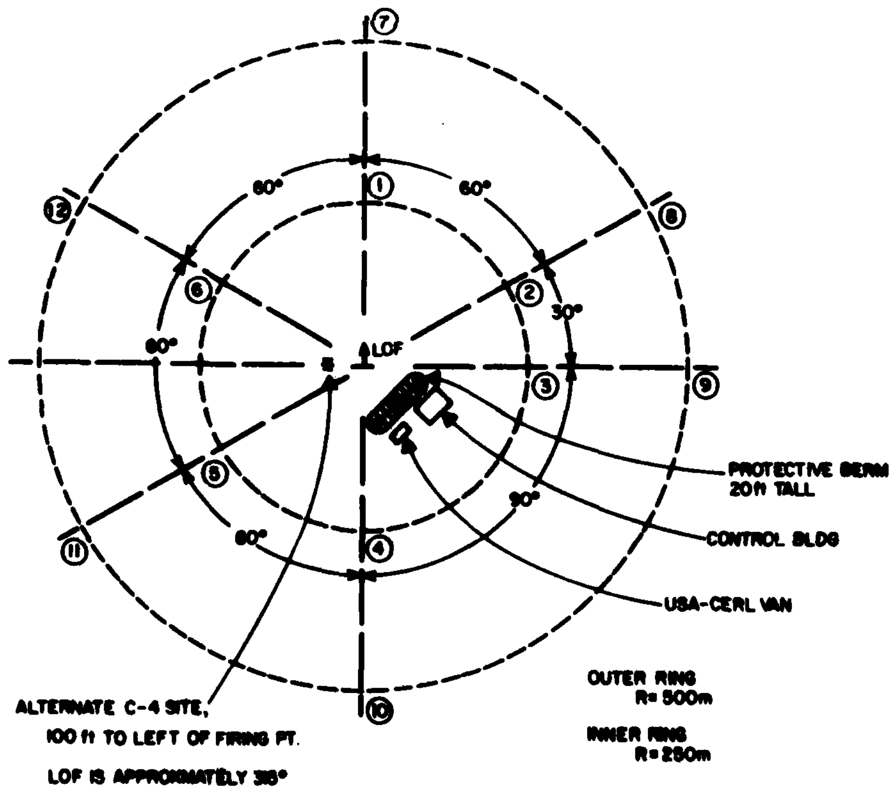


Figure 2. Microphone layout, White Sands Missile Range, NM, January 1985.

Table 1

Firing Sequence at WSMR*, January 1985

Event(s)	Type
#11, #12	C-4 (1-1/4 lb)
#13	Single MLRS
#14–#19	6 Ripple-Fired MLRS (4.5 Seconds Apart)
#20, #23	C-4 (1-1/4 lb)

*Events 1 through 10 were used as part of the C-4 site test. The data are in Appendix B.

Table 2

Analyzed Data in dB Listed by Event
CSEL of C-4 Blasts and Rocket Ignitions

Event	1	2	3	4	5	6
11-C4	124.8	120.4	121.0	119.9	123.3	125.6
12-C4	123.5	118.6	119.5	119.0	123.3	125.3
13-Rocket Ignition	111.1	111.3	112.8	116.5	115.4	112.1
14-Rocket Ignition	110.9	111.2	114.0	118.2	115.4	113.9
15-Rocket Ignition	110.8	109.0	112.9	115.3	113.0	110.1
16-Rocket Ignition	110.1	109.3	112.0	111.3	115.8	108.5
17-Rocket Ignition	111.8	110.1	113.1	112.3	116.1	109.7
18-Rocket Ignition	110.5	109.9	112.0	115.3	115.7	109.6
19-Rocket Ignition	109.6	110.5	113.2	112.8	115.5	111.2
20-C4	122.4	119.8	120.0	119.0	122.1	122.0
21-C4	122.2	118.4	119.5	118.3	121.4	123.7
22-C4	122.3	119.4	119.7	118.9	121.4	122.9
23-C4	122.8	119.3	119.7	118.6	121.0	122.3

the overall weapon-device directivity pattern. Corrections were made to form a symmetrical pattern. Appendix D lists the resultant data by weapon/device.

Table 3, which is based on the data given in Appendix D, lists the data as they are included in the BNOISE 3.2 weapons input table. In the table, the reference distance is 250 m. At this distance, 1-1/4 lb (0.57 kg) of C-4 exploded on the ground typically produces a CSEL of 115 dB.

Rocket Motor Noise Measurements

Currently, AEHA can include motor noise assessments as part of a general noise assessment as required on a case-by-case basis; the computerized INCS does not include a module for this. In the future a module in INCS may include this type of noise or it can be modeled as for a helicopter. With this case-by-case application of AEHA and the possible future INCS module in mind, rocket motor noise emission data were gathered for the MLRS. These data can be used by AEHA or as part of a new noise assessment module in INCS, if one is developed.

Table 4 lists the measured A-weighted SEL (ASEL) at the inner ring sites. Maximum 1/2 second, 1/3-octave data were developed, and in a similar fashion to helicopters, ASEL versus distance curves were developed. These are listed in Table 5 for the directions (with respect to LOF) indicated.

Table 3

Input Data in dB for BNOISE 3.2 Position (Degrees)

	0	30	60	90	120	150	180	210	240	270	300	330	Ave
Value	106.3	107.4	108.2	111.0	112.7	114.0	115.0	114.0	112.7	111.0	108.2	107.4	111.6
Value re rear of MLRS	-8.7	-7.6	-6.8	-4.0	-2.3	-1.0	0	-1.0	-2.3	-4.0	-6.8	-7.6	-5.3

Table 4

Measured Average ASEL in dB for Rocket Motor

Site	ASEL
1	120.4
2	115.6
3	114.4
4	98.9
5	109.9
6	114.7

Table 5

Computer ASEL vs Distance by Site, dB

Distance (m)	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6
50	127.0	123.1	121.7	106.0	116.0	121.9
100	124.0	120.1	118.7	103.0	113.0	118.8
200	121.0	117.1	115.6	99.9	110.0	115.8
500	117.0	113.1	111.7	96.0	106.0	111.9
1000	114.0	110.1	108.7	93.0	103.0	108.8
2000	111.0	107.1	105.6	89.9	100.0	105.8
5000	107.0	103.1	101.7	86.0	96.0	101.9
10000	104.0	100.1	98.7	83.0	93.0	98.8

3 CONCLUSIONS

This report gives the acoustic directivity patterns for the ignition noise of the MLRS M270 Armored Vehicle Mounted Rocket Launcher. These data supplement the pattern data presented in USA-CERL Technical Report N-60. These supplemental pattern data have been included in the weapon directivity pattern load module of BNOISE 3.2 and made available to users of the Integrated Noise Contour System. The motor noise emissions were also gathered for future use.

APPENDIX A: MEASUREMENT SITE COORDINATES

This appendix contains three documents from WSMR.

1. Coordinates and diagram of the earthen berm.

2. Coordinates of the preliminary measurement sites and the locations of three USA-CERL personnel (P1, P2, and P3).

3. Locations of final adjusted measurement sites #3, #7, and #9 and the alternate C-4 site, #D.

Notes:

1. Measurement site numbers correspond with those shown in Figure 2.

2. For WSTM coordinates, X is east-west, Y is north-south, H is altitude above mean sea level.

3. The firing point WSTM coordinates are:

X = 545,832 ft
Y = 431,405 ft
H = 4,130 ft

DEFENSE MAPPING AGENCY

HYDROGRAPHIC/TOPOGRAPHIC CENTER
GEODETIC SURVEY SQUADRON
DETACHMENT 2
WHITE SANDS MISSILE RANGE
NEW MEXICO 88002

sl
Mr.St.Leon/sy/3718
25 February 1985

SURVEY #56-85

WSD-73 (NAD)

MLRS BERM POINTS

AT TULA-G

Surveyed 14 February 1985. Filed in MLRS Folder.

GEODETIC COORDINATES	WSTM COORDINATES*	WSCS COORDINATES	UTM COORDINATES
BERM POINT #1			
ϕ = 33° 04' 40.8808"	X = 546,084.94 ft	E = 546,095.04 ft	E = 389,590.81 m
λ = 106 10 58.4145	Y = 431,599.34	N = 498,100.27	N = 3,660,367.26
$\Delta\alpha$ = 00 04 56	H = 4,104.07	Z = 4,053.28	H = 1,250.92
BERM POINT #2			
ϕ = 33 04 40.6485	X = 546,187.22	E = 546,197.35	E = 389,621.89
λ = 106 10 57.2129	Y = 431,576.01	N = 498,076.94	N = 3,660,359.76
$\Delta\alpha$ = 00 04 56	H = 4,104.95	Z = 4,053.93	H = 1,251.19
BERM POINT #3			
ϕ = 33 04 37.2488	X = 546,149.09	E = 546,159.21	E = 389,608.94
λ = 106 10 57.6668	Y = 431,232.35	N = 497,733.20	N = 3,660,255.19
$\Delta\alpha$ = 00 04 56	H = 4,104.24	Z = 4,053.27	H = 1,250.98
BERM POINT #4			
ϕ = 33 04 37.4143	X = 546,054.89	E = 546,064.99	E = 389,580.30
λ = 106 10 58.7735	Y = 431,248.95	N = 497,749.80	N = 3,660,260.61
$\Delta\alpha$ = 00 04 55	H = 4,104.34	Z = 4,053.58	H = 1,251.01
BERM POINT #5			
ϕ = 33 04 39.6399	X = 546,116.01	E = 546,126.17	E = 389,599.80
λ = 106 10 58.0514	Y = 431,473.96	N = 497,974.87	N = 3,660,328.94
$\Delta\alpha$ = 00 04 56	H = 4,124.43	Z = 4,073.55	H = 1,257.13
BERM POINT #6			
ϕ = 33 04 39.5763	X = 546,144.82	E = 546,154.98	E = 389,608.55
λ = 106 10 57.7130	Y = 431,467.58	N = 497,968.48	N = 3,660,326.88
$\Delta\alpha$ = 00 04 56	H = 4,123.63	Z = 4,072.69	H = 1,256.88

SURVEY #56-85 MLRS BERM POINTS AT TULA-G
25 February 1985

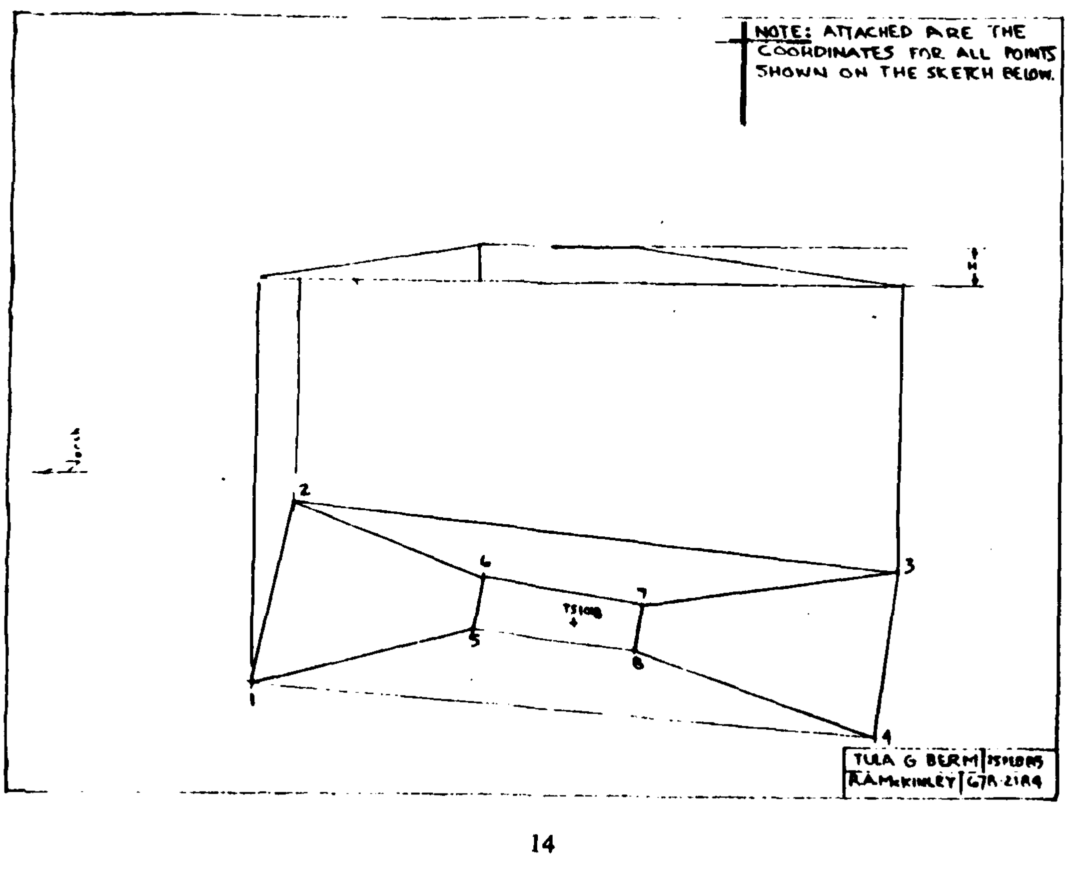
GEODETIC COORDINATES	WSTM COORDINATES	WSCS COORDINATES	UTM COORDINATES
BERM POINT #7			
φ = 33° 04' 38.6923"	X = 546,129.98 ft	E = 546,140.15 ft	E = 389,603.68 m
λ = 106 10 57.8889	Y = 431,378.22	N = 497,879.10	N = 3,660,299.71
Δα = 00 04 56	H = 4,125.56	Z = 4,074.64	H = 1,257.47
BERM POINT #8			
φ = 33 04 38.7356	X = 546,104.15	E = 546,114.30	E = 389,595.82
λ = 106 10 58.1924	Y = 431,382.55	N = 497,883.43	N = 3,660,301.13
Δα = 00 04 56	H = 4,125.31	Z = 4,074.45	H = 1,257.40

TRUE AZIMUTH (from North) BERM POINT #4 TO BERM POINT #1 = 04° 59' 00"

TERRY D. BECKETT
Chief, Detachment 2

TS 1018

WSTM COORDINATES
X = 546,121.73 ft
Y = 431 416.34
H = 4125.92



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sl
Mr.St.Leon/sy/3718
27 November 1984

SURVEY #494-84

WSD-73 (NAD)

MLRS NOISE POINTS

Surveyed 8 November 1984. Filed in MLRS Folder.

GEODETIC COORDINATES	WSTM COORDINATES	WSCS COORDINATES	UTM COORDINATES
MLRS NOISE 1			
ϕ = 33° 04' 44.7010"	X = 545,252.01 ft	E = 545,261.92 ft	E = 389,338.50 m
λ = 106 11 08.1966	Y = 431,984.25	N = 498,485.27	N = 3,660,487.77
Δα = +00 04 50	H = 4,095.25	Z = 4,046.30	H = 1,248.23
MLRS NOISE 2			
ϕ = 33 04 46.7910	X = 546,043.91	E = 546,053.99	E = 389,580.62
λ = 106 10 58.8866	Y = 432,196.62	N = 498,697.68	N = 3,660,549.41
Δα = +00 04 55	H = 4,097.67	Z = 4,047.01	H = 1,248.97
MLRS NOISE 3			
ϕ = 33 04 36.8472	X = 546,623.13	E = 546,633.35	E = 389,753.23
λ = 106 10 52.0967	Y = 431,192.45	N = 497,693.29	N = 3,660,241.20
Δα = +00 04 59	H = 4,106.26	Z = 4,054.24	H = 1,251.59
MLRS NOISE 4			
ϕ = 33 04 33.2115	X = 546,411.46	E = 546,421.65	E = 389,687.31
λ = 106 10 54.5904	Y = 430,824.69	N = 497,325.45	N = 3,660,129.96
Δα = +00 04 58	H = 4,106.42	Z = 4,054.82	H = 1,251.64
MLRS NOISE 5			
ϕ = 33 04 31.1214	X = 545,619.27	E = 545,629.28	E = 389,445.10
λ = 106 11 03.9034	Y = 430,612.32	N = 497,113.03	N = 3,660,068.31
Δα = +00 04 53	H = 4,102.73	Z = 4,052.84	H = 1,250.51
MLRS NOISE 6			
ϕ = 33 04 36.8684	X = 545,039.41	E = 545,049.29	E = 389,270.66
λ = 106 11 10.7080	Y = 431,192.34	N = 497,693.18	N = 3,660,247.29
Δα = +00 04 49	H = 4,099.83	Z = 4,051.27	H = 1,249.63
MLRS NOISE 7			
ϕ = 33 04 50.4462	X = 544,672.00	E = 544,681.80	E = 389,164.01
λ = 106 11 15.0034	Y = 432,564.11	N = 499,065.25	N = 3,660,666.70
Δα = +00 04 47	H = 4,104.37	Z = 4,056.71	H = 1,251.02

SURVEY #494-84 MLRS NOISE POINTS
27 November 1984

GEODETIC COORDINATES	WSTM COORDINATES	WSCS COORDINATES	UTM COORDINATES
MLRS NOISE 8			
φ = 33° 04' 54.6221"	X = 546,256.07 ft	E = 546,266.19 ft	E = 389,648.33 m
λ = 106 10 56.3799	Y = 432,988.39	N = 499,489.63	N = 3,660,789.85
Δα = +00 04 57	H = 4,091.07	Z = 4,039.98	H = 1,246.96
MLRS NOISE 9			
φ = 33 04 34.7348	X = 547,415.35	E = 547,425.76	E = 389,993.80
λ = 106 10 42.7904	Y = 430,980.11	N = 497,480.91	N = 3,660,173.43
Δα = +00 05 04	H = 4,110.09	Z = 4,056.26	H = 1,252.76
MLRS NOISE 10			
φ = 33 04 27.4646	X = 546,991.48	E = 547,001.79	E = 389,861.80
λ = 106 10 47.7842	Y = 430,244.70	N = 496,745.34	N = 3,659,950.99
Δα = +00 05 01	H = 4,107.17	Z = 4,054.19	H = 1,251.87
MLRS NOISE 11			
φ = 33 04 23.2888	X = 545,407.12	E = 545,417.08	E = 389,377.39
λ = 106 11 06.4097	Y = 429,820.39	N = 496,320.93	N = 3,659,827.83
Δα = +00 04 51	H = 4,107.06	Z = 4,057.51	H = 1,251.84
MLRS NOISE 12			
φ = 33 04 34.7803	X = 544,247.68	E = 544,257.43	E = 389,028.59
λ = 106 11 20.0157	Y = 430,980.19	N = 497,480.98	N = 3,660,185.71
Δα = +00 04 44	H = 4,122.97	Z = 4,076.07	H = 1,256.68
MLRS NOISE P1			
φ = 33 04 28.6437	X = 544,787.66	E = 544,797.49	E = 389,190.73
λ = 106 11 13.6802	Y = 430,360.73	N = 496,861.39	N = 3,659,994.87
Δα = +00 04 47	H = 4,106.14	Z = 4,058.01	H = 1,251.55
MLRS NOISE P2			
φ = 33 04 49.2686	X = 546,875.32	E = 546,885.60	E = 389,834.93
λ = 106 10 49.1114	Y = 432,448.22	N = 498,949.34	N = 3,660,622.86
Δα = +00 05 01	H = 4,102.37	Z = 4,049.88	H = 1,250.40
MLRS NOISE P3			
φ = 33 04 35.1572	X = 547,256.94	E = 547,267.32	E = 389,945.70
λ = 106 10 44.6512	Y = 431,022.57	N = 497,523.38	N = 3,660,186.98
Δα = +00 05 03	H = 4,110.12	Z = 4,056.66	H = 1,252.77

SURVEY #494-84 MLRS NOISE POINTS
27 November 1984

POINT TO POINT	WSTM AZIMUTH) (from North)
L-597 B to MLRS NOISE 1	315° 00' 18"
" " MLRS NOISE 2	15 00 02
" " MLRS NOISE 3	104 59 55
" " MLRS NOISE 4	135 00 01
" " MLRS NOISE 5	195 00 28
" " MLRS NOISE 6	255 00 28
" " MLRS NOISE 7	314 59 55
" " MLRS NOISE 8	15 00 02
" " MLRS NOISE 9	105 00 05
" " MLRS NOISE 10	134 59 58
" " MLRS NOISE 11	195 00 09
" " MLRS NOISE 12	255 00 14
" " MLRS NOISE P1	225 00 22
" " MLRS NOISE P2	44 59 56
" " MLRS NOISE P3	105 00 03

Terry D. Beckett

TERRY D. BECKETT
Chief, Detachment 2

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NEW MEXICO 88002

sl

Mr.St.Leon/sy/3718
19 December 1984

SURVEY #558-84

WSD-73 (NAD)

MLRS NOISE POINTS

Surveyed 13 December 1984. Filed in MLRS Folder.

GEODETIC COORDINATES	WSTM COORDINATES	WSCS COORDINATES	UTM COORDINATES
MLRS NOISE 3A			
ϕ = 33° 04' 44.6854"	X = 546,411.43 ft	E = 546,421.61 ft	E = 389,691.79 m
λ = 106 10 54.5711	Y = 431,984.33	N = 498,485.35	N = 3,660,483.31
Δα = +00 04 58	H = 4,103.6t	Z = 4,052.1t	H = 1,250.8t
MLRS NOISE 7A			
ϕ = 33 04 49.3615	X = 544,781.39	E = 544,791.21	E = 389,196.92
λ = 106 11 13.7196	Y = 432,454.62	N = 498,955.74	N = 3,660,632.92
Δα = +00 04 47	H = 4,102.6t	Z = 4,054.7t	H = 1,250.5t
MLRS NOISE 9A			
ϕ = 33 04 51.0092	X = 547,051.14	E = 547,061.46	E = 389,889.19
λ = 106 10 47.0422	Y = 432,624.40	N = 499,125.56	N = 3,660,675.86
Δα = +00 05 02	H = 4,108.3t	Z = 4,055.4t	H = 1,252.2t
MLRS NOISE D			
ϕ = 33 04 38.2579	X = 545,761.04	E = 545,771.07	E = 389,491.09
λ = 106 11 02.2254	Y = 431,333.78	N = 497,834.65	N = 3,660,287.60
Δα = +00 04 54	H = 4,101.8t	Z = 4,051.7t	H = 1,250.2t

Terry D. Beckett

TERRY D. BECKETT
Chief, Detachment 2

APPENDIX B: COMPARISON OF VEHICLE AND ALTERNATE C-4 DENOTATION SITES (Figure 2)

As shown in Tables B1 and B2, the differences are random, usually less than 1 dB, and inconsequential.

Table B1

Inner Ring Sites, Comparison Between Vehicle and Alternate C-4 Sites for Placing Calibrations 5-lb Charge (CSEL)

	Site No.	1	2	3	4	5	6
MLRS Vehicle Site (Victor)	Event No.						
	2	112.0	113.2	111.9	106.5	111.0	109.8
	4	112.6	112.1	113.6	109.4	109.6	107.2
	6	111.6	111.1	111.8	108.4	110.4	111.0
	8	112.1	111.2	112.2	108.1	108.4	109.5
	9	112.3	111.1	112.9	108.1	108.8	108.9
	10	112.0	111.6	112.1	107.1	109.2	107.6
	Average	112.1	111.7	112.4	107.9	109.6	109.0
Alternate C-4 Site	1	111.6	111.3	120.9	108.5	110.8	109.6
	3	113.4	111.3	111.5	108.4	111.0	109.9
	5	112.7	111.9	110.4	108.5	109.5	108.8
	7	113.5	111.2	111.4	109.1	111.0	110.0
	Average	112.8	111.4	113.6	108.6	110.6	109.6
Difference, Vehicle Site Minus Alternate		−0.7	+0.3	−1.2	−0.7	−1.0	−0.6

Table B2

Outer Ring Sites, Comparison Between Vehicle and Alternate C-4 Sites for Placing Calibrations 5-lb Charge (CSEL)

	Site No.	1	2	3	4	5	6
MLRS Vehicle Site	Event No.						
	2	77.5	78.6	76.6	72.4	75.7	75.4
	4	77.7	78.0	78.6	73.8	74.4	72.5
	6	76.5	76.2	77.9	74.3	73.1	73.8
	8	76.9	76.7	78.4	73.4	71.2	75.6
	9	76.1	77.7	78.9	74.4	71.8	72.7
	10	75.8	77.2	77.3	73.3	72.8	73.6
	Average	76.8	77.4	78.0	73.6	73.2	74.0
Alternate C-4 Site	1	76.6	76.5	76.2	74.9	74.5	74.9
	3	78.3	76.7	76.7	74.6	74.5	75.2
	5	76.3	77.8	76.4	73.9	74.5	71.3
	7	77.9	76.5	76.9	74.2	74.4	74.1
	Average	77.3	76.9	76.6	74.4	74.5	73.9
Difference, Vehicle Site Minus Alternate		−0.475	+0.525	+1.4	−0.8	−1.3	+0.1

APPENDIX C:
ANALYSIS* OF MLRS IGNITION DATA

Table C1

Average of Events by Grouping and Position

Events	1	2	3	4	5	6	Group
11,12	124.2	119.6	120.3	119.5	123.3	125.5	C1
13-19	110.7	110.3	112.9	115.1	115.4	111.1	R1
20–23	122.4	119.3	119.7	118.7	121.5	122.8	C2

Table C2

Average of Consecutive Sets of C-4

	1	2	3	4	5	6	Average
C12	123.4	119.5	120.0	119.1	122.5	124.4	122.0

Table C3

Correction Table To Convert Measured Rocket Data to Omnidirectional Site Independent Data re 5 lb of C-4 (119 dB at 250 m)

	1	2	3	4	5	6
CR12	4.4	0.5	1.0	0.1	3.5	5.4

Table C4

Corrected Rocket Data by Group re 5 lb of C-4 (119 dB at 250 m)

	1	2	3	4	5	6
R1	106.3	109.8	111.9	115.0	111.9	105.7

*As described in USA-CERL TR-N-60 Supplement 2, Appendix C.

Table C5

Rocket Data Corrected to Standard Measurement Positions re 5 lb of C-4

	1	2	3	4	5	6
R1	106.3	109.8	113.4	115.0	111.9	105.7

*Value altered from the 90° measurement position to the 120° standard position.

Table C6

Rocket Data Averaged To Be Symmetrical re 5 lb of C-4

	1	2	3	4	5	6
R1	106.3	108.2	112.7	115.0	112.7	108.2

Table C7

Input Data for BNOISE 3.2 Position (Degrees)

	0	30	60	90	120	150	180	210	240	270	300	330	Ave
Value	106.3	107.4	108.2	111.0	112.7	114.0	115.0	114.0	112.7	111.0	108.2	107.4	111.6
Value r3 rear of gun	−8.7	−7.6	−6.8	−4.0	−2.3	−1.0	0	−1.0	−2.3	−4.0	−6.8	−7.6	−5.3

Table C8

CSEL Outer Ring Data
C-4 From Blue Box, Rocket-Ignition From Data 6000

							C4 from data 6000	
Event	**7**	**8**	**9**	**10**	**11**	**12**	**11**	**12**
11-C4	118.5	114.2	114.9	113.7	–	–	118.4	121.2
12-C4	117.4	111.7	112.4	112.3	120.6	121.5	117.3	119.4
13-Rocket	107.1	103.6	101.6	108.4	113.2	107.9	113.2	107.9
14-Rocket	107.6	104.2	102.8	109.5	113.4	109.6	113.4	109.6
20-C4	115.4	111.7	111.6	111.7	117.4	115.8	115.5	115.9
21-C4	114.2	110.5	111.1	110.7	116.7	117.8	114.9	117.9
22-C4	114.5	111.2	111.6	111.6	116.5	117.2	114.8	117.2
23-C4	114.7	111.9	112.5	111.3	116.4	116.4	114.7	116.6

Table C9

Average of Events by Grouping and Position

	7	8	9	10	11	12	11	12
C1	118.0	113.1	113.8	113.1	120.6	121.5	117.9	120.4
R1	107.4	103.9	102.2	109.0	113.3	108.8	113.3	108.8
C2	114.7	111.4	111.7	111.3	116.8	116.9	115.0	117.0

Table C10 (Tables C1-C9)

Differences in dB Between the Inner and Outer Rings by Radial Position

	1-7	2-8	3-9	4-10	5-11	6-12	5-11	6-12
C1	6.2	6.5	6.5	6.4	2.7	4.0	5.4	5.1
R1	3.3	6.4	10.7	6.1	2.1	2.3	2.1	2.3
C2	7.7	7.9	8.0	7.4	4.7	5.9	6.5	5.8

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